

CLAIMS

What is claimed is:

1. A process of all-optical two-fiber, bidirectional buses for networking of one **optical** wavelength Wavelength Division Multiplexed (WDM) or a plurality of **optical** wavelengths Dense Wavelength Division Multiplexed (DWDM) to each one of $2MN$ Wavelength Division Multiplexed (WDM) transmission channels in each transmission fiber, where $M=1,2,3,4,5,\dots$ and $N=1,2,3,4,5,\dots$ for a method of protected Point-To-Point, Point-To-Multipoint and Broadcast multi-bus networking comprising:

a Switching Bus Interface Node **optical** apparatus having first input/output bidirectional bus terminal in first bus direction and second input/output bidirectional bus terminal in second bus direction, said first and said second input bus terminals Wavelength Division Demultiplexed by the Transmit/Receive Interface to $2MN$ -first and $2MN$ -second bus input terminals and said first and said second bus output terminals Wavelength Division Multiplexed by said Transmit/Receive Interface from $2MN$ -first and $2MN$ -second bus output terminals, first and second input/output bidirectional bus-to-bus terminals said first and said second bus-to-bus output terminals Wavelength Division Multiplexed by said Transmit/Receive Interface from $2MN$ -first and $2MN$ -second bus-to-bus output terminals, MN -first add input terminals and MN -first drop output terminals in said first bus direction, MN -second add input terminals and MN -second drop output terminals in said second bus direction, MN -first append input terminals and MN -first drop-continue output terminals in said first bus direction, MN -second append input terminals and MN -second drop-continue output terminals in said second bus direction, and

2. The Switching Bus Interface Node **optical** apparatus of claim 1 with said in claim 1 said first and said second bidirectional bus-to-bus terminals for coupling said first bidirectional bus-to-bus terminal in said apparatus installed on in-between second bus with said first or said second bidirectional bus-to-bus terminal in said apparatus installed on first bus and for coupling said second bidirectional bus-to-bus terminal in said apparatus installed on said second bus with said first or said second bidirectional bus-to-bus terminal in said apparatus installed on third bus for protection networking of WDM channels between said second and said first buses, for service networking of WDM channels between said first and said third buses and for in-service network expansion by coupling not coupled said first or said second bidirectional bus-to-bus terminal in said apparatus installed on said first bus with said first or said second bidirectional bus-to-bus terminal in said apparatus installed on a fourth bus or by coupling not coupled said first or said second bidirectional bus-to-bus terminal in said apparatus installed on said third bus with said first or said second terminal in said apparatus installed on fifth bus comprising;

a method of partitioning of transmission bandwidth in each bus and bus-to-bus transmission fiber to first and second bandwidths, said first service bandwidth for service routing and said second protection bandwidth for protection routing on said in-between second bus, said first bandwidth for protection routing and said second bandwidth for service routing on said first and said third buses, and

3. The Switching Bus Interface Node **optical** apparatus of claim 1 with M identical Switching Module **optical** apparatuses, $M=1,2,3,4,5,\dots$, each apparatus ($M=1$) having identical first and second **optical** switches, third **optical** switch and N-first and N-second

identical **optical** power couplers, $N=1,2,3,4,5,\dots$ and comprising:

said first **optical** switch having N-first input terminals selected from said in claim 1 ($M=1$) $2N$ -first bus input terminals in said in claim 2 first or second service bandwidth on bus with installed said apparatus, said N-first add input terminals and said N-first drop output terminals, N-first through terminals for coupling to N-first **optical** power couplers, and $2N$ -third terminals for coupling to said third **optical** switch;

said second **optical** switch having N-second input terminals selected from said in claim 1 ($M=1$) said $2N$ -second bus input terminals in said in claim 2 service bandwidth on said bus with installed said apparatus, said N-second add input terminals and said N-second drop output terminals, N-second through terminals for coupling to N-second **optical** power couplers, and $2N$ -third terminals for coupling to said third **optical** switch;

said N-first **optical** power couplers each having first, second, third and fourth terminals to optically couple said first to said third and said fourth terminals and said second to said third and said fourth terminals, said first terminal for coupling to one of said N-first through terminals of said first **optical** switch, said second terminal for coupling to one of said in claim 4 N-second output terminals of first Bus-To-Bus Switch **optical** apparatus, said third terminal for coupling to one of said in claim 1 ($M=1$) N-first drop-continue output terminals, said fourth terminal for coupling to one of N-first bus output terminals selected from said in claim 1 ($M=1$) $2N$ -first bus output terminals in said in claim 2 service bandwidth on bus with installed said apparatus;

said N-second **optical** power couplers each having first, second, third and fourth terminals to optically couple said first to said third and said fourth terminals and said second terminal to said third and said fourth terminals, said first terminal for coupling to one of said N-second through terminals of said second **optical** switch, said second terminal for coupling to one of said in claim 4 N-second output terminals of second Bus-To-Bus Switch **optical** apparatus, said third terminal for coupling to one of said in claim 1 (M=1) N-second drop-continue output terminals, said fourth terminal for coupling to one of N-second bus output terminals selected from said in claim 1 (M=1) 2N-second bus output terminals in said in claim 2 service bandwidth on said bus with installed said apparatus;

said third **optical** switch having N-first bus input terminals selected from said in claim 1 (M=1) 2N-first bus input terminals in said in claim 2 protection bandwidth on bus with installed said apparatus, N-second bus input terminals selected from said in claim 1 (M=1) 2N-second bus input terminals in said in claim 2 protection bandwidth on said bus with installed said apparatus, N-third input terminals for coupling to said in claim 4 N-third output terminals of first Bus-To-Bus Switch **optical** apparatus, N-fourth input terminals for coupling to said in claim 4 N-third output terminals of second Bus-To-Bus Switch **optical** apparatus, 2N-fifth terminals for coupling to said 2N-third terminals of said first **optical** switch, 2N-sixth terminals for coupling to said 2N-third terminals of said second **optical** switch, N-seventh output terminals for coupling to N-first bus output terminals selected from said in claim 1 (M=1) 2N-first bus output terminals in said in claim 2 protection bandwidth on said bus with installed said apparatus, N-eighth output terminals for coupling to N-second bus output terminals selected from said in claim 1 (M=1) 2N-second

bus output terminals in said in claim 2 protection bandwidth on said bus with installed said apparatus, N-ninth output terminals for coupling to N-first bus-to-bus output terminals selected from said in claim 1 ($M=1$) 2N-first bus-to-bus output terminals in said in claim 2 protection bandwidth on said bus with installed said apparatus, N-tenth output terminals for coupling to N-second bus-to-bus output terminals selected from said in claim 1 ($M=1$) 2N-second bus-to-bus output terminals in said in claim 2 protection bandwidth on said bus with installed said apparatus, N-eleventh output terminals for coupling to said in claim 4 N-first input terminals of first Bus-To-Bus Switch **optical** apparatus, N-twelfth output terminals for coupling to said in claim 4 N-first input terminals of second Bus-To-Bus Switch **optical** apparatus, and

4. Two identical first and second Bus-To-Bus Switch **optical** apparatuses, said first having M-first and M-second identical Bus-To-Bus Switching Module optical apparatuses, said second having said M-first and said M-second Bus-To-Bus Switching Module optical apparatuses, $M=1,2,3,4,5,\dots$ comprising:

said first Bus-To-Bus Switching Module **optical** apparatus having N-first input terminals for coupling to said in claim 3 Switching Module **optical** apparatus, N-second input terminals for coupling to said in claim 1 ($M=1$) N-first append input terminals, N-third input terminals for coupling to said in claim 6 ($M=1$) N-first bus-to-bus input terminals, N-first output terminals for coupling to N-first bus-to-bus output terminals selected from said in claim 1 ($M=1$) 2N-first bus-to-bus output terminals in said in claim 2 service bandwidth on said bus with installed said apparatus, N-second and N-third output terminals for coupling to said in claim 3 Switching Module **optical** apparatus:

said second Bus-To-Bus Switching Module **optical** apparatus having N-first input terminals for coupling to said in claim 3 Switching Module **optical** apparatus, N-second input terminals for coupling to said in claim 1 (M=1) N-second append input terminals, N-third input terminals for coupling to said in claim 6 (M=1) N-second bus-to-bus input terminals, N-first output terminals for coupling to N-second bus-to-bus output terminals selected from said in claim 1 (M=1) 2N-second bus-to-bus output terminals in said in claim 2 service bandwidth on said bus with installed said apparatus, N-second and N-third output terminals for coupling to said in claim 3 Switching Module **optical** apparatus:

5. Two identical first and second Bus-To-Bus Switching Module **optical** apparatuses of claim 4 each one comprising:

N optional **optical** amplifiers each having first and second terminals, said first terminal for coupling to one of said in claim 4 N-first input terminals, said second **optical** terminal for coupling to one of N-first **optical** power couplers;

N-first **optical** power couplers each having first, second, third and fourth terminals to optically couple said first to said third and said fourth terminals and said second to said third and said fourth terminals, said first terminal for coupling to one of said N **optical** amplifiers, said second terminal for coupling to one of N-first 1:2 **optical** switches, said third terminal for coupling to one of N-second 2:1 **optical** switches, said fourth terminal for coupling to one of said in claim 4 N-first output terminals;

said N-first 1:2 **optical** switches each having first, second and third terminals to selectively optically couple said first and said second terminals or said first and said third terminals, said first terminal for coupling to one of said in claim 4 N-second input terminals, said second terminal for coupling to said second terminal of one of said N-first **optical** power couplers, said third terminal for coupling to first terminal of one of N-second **optical** power couplers;

said N-second 2:1 **optical** switches each having first, second and third terminals to selectively optically couple said first and said third terminals or said second and said third terminals, said first terminal for coupling to said third terminal of one of said N-first **optical** power couplers, said second terminal for coupling to said second terminal of one of N-third **optical** switches, said third terminal for coupling to second terminal of one of N-second **optical** power couplers;

said N-third 1:2 **optical** switches each having first, second and third terminals to selectively optically couple said first and said second terminals or said first and said third terminals, said first terminal for coupling to one of said in claim 4 N-third input terminals, said second terminal for coupling to said second terminal of one of said N-second **optical** switches, said third terminal for coupling to one of said in claim 4 N-third output terminals;

said N-second **optical** power couplers each having first, second and third terminals to optically couple said first to said third terminal and said second to said third terminal, said first terminals for coupling to said third terminal of one of said N-first 1:2 **optical** switches, said second terminal for coupling to said third terminal of one of said N-second 2:1

optical switches, said third terminal for coupling to one of said N-second output terminals;

6. The Switching Bus Interface Node **optical** apparatus of claim 1 with a Bus-To-Bus Broadcast **optical** apparatus having first and second input terminals for coupling to said in claim 1 said first and said second bus-to-bus input terminals, and third, fourth, fifth and sixth output terminals, said third and said fourth output terminals for coupling to first and second power coupler **optical** apparatuses, said fifth and said sixth output terminals further Wavelength Division Demultiplexed by the Transmit/Receive Interface to MN-first and MN-second bus-to-bus input terminals with WDM channels selected from said in claim 2 service bandwidth on bus with said apparatus, $M=1,2,3,\dots$, $N=1,2,3,\dots$ comprising;

said first power coupler **optical** apparatus having first, second, third and fourth terminals to optically couple said first to said third and said fourth terminals and said second to said third and said fourth terminals, said first terminal for coupling to said in claim 1 first bus input terminal, said second terminal for coupling to said third terminal of said Bus-To-Bus Broadcast **optical** apparatus, said third terminal for coupling to a Line Interface, said fourth terminal for coupling to input terminal of said in claim 1 WDM Demultiplexer of said first bus input terminal;

said second power coupler **optical** apparatus having first, second, third and fourth terminals to optically couple said first to said third and said fourth terminals and said second to said third and said fourth terminals, said first terminal for coupling to said in claim 1 second bus input terminal, said second terminal for coupling to said fourth

terminal of said Bus-To-Bus Broadcast **optical** apparatus, said third terminal for coupling to a Line Interface, said fourth terminal for coupling to input terminal of said in claim 1 WDM Demultiplexer of said second bus input terminal;

first **optical** sub-band filter having first, second and third terminals to optically filter MN WDM channels in the same as said in claim 2 protection bandwidth on bus with said apparatus from said first terminal to said second terminal, to optically filter MN WDM channels in the same as said in claim 2 service bandwidth on said bus with said apparatus from said first terminal to said third terminal, said first terminal for coupling to said first input terminal, said second terminal for coupling to said third output terminal, said third terminal for coupling to first terminal of **optical** power coupler;

second **optical** sub-band filter having first, second and third terminals to optically filter MN WDM channels in the same as said in claim 2 protection bandwidth on bus with said apparatus from said first terminal to said second terminal, to optically filter MN WDM channels in the same as said in claim 2 service bandwidth on said bus with said apparatus from said first terminal to said third terminal, said first terminal for coupling to said second input terminal, said second terminal for coupling to said fourth output terminal, said third terminal for coupling to second terminal of **optical** power coupler;

said **optical** power coupler having first, second, third and fourth terminals to optically couple said first to said third and said fourth terminals and said second to said third and said fourth terminals, said first terminal for coupling to said third terminal of said first **optical** sub-band filter, said second terminal for coupling to said third terminal of said

second optical sub-band filter, said third terminal for coupling to said fifth output terminal, said fourth terminal for coupling to said sixth output terminal.